IMPRS on Multiscale Biosystems

Title: Size control during eukaryotic cell division

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Project description: Defects in cell growth and division are among the most prominent attributes of cancerous tumors. What determines the size of cells? How is cell size controlled and regulated during division? Despite decades of research, many of the fundamental questions of cell size control remain unanswered until today. We use an amoeboid model organism that shares many homologies with the cells of higher organisms to study fundamental aspects of size control during cell division. Based on electric pulse-induced cell fusion, we produce large multinucleate agglomerates. The subsequent fission of these giant cells into smaller daughters offers a unique framework to perform a systematic study of the division process. We will use this setting to address the following questions: how is the intracellular material distributed over the daughter cells? In particular, what is the fate of the individual nuclei during division? Does the number of nuclei determine the number of daughter cells? Our preliminary data shows that in the giant cells, the positions of the nuclei are not independent of each other. How do they interact? We have established an automated imaging platform to perform parallel observations of the division in a large number of cell cultures. Based on this setup, the candidate will acquire large data sets to obtain statistically solid information on the size and shape characteristics, the distribution of organelles across the daughter cells and other relevant parameters. Together with our repertoire of mutant cell lines, this will allow us to identify key factors and determinants that govern cell size control and division. At the subsequent stages of the project, the experimental approach can be complemented with theoretical modeling. The theory will make predictions about the number and size of the daughter cells starting with the hypothesis that division of the giant cells is a purely random process. The comparison of these predictions with the experimental data will lead to more detailed modeling hypotheses that include the coordinated action between the nuclei.

Required background: We seek a candidate with a background in physics, preferentially biophysics. Also applications of interested students from other related fields (e.g. cell biology) are welcome. The project has a mostly experimental focus. Experience with imaging and cell culture techniques are appreciated but not required. Candidates with an additional background in mathematical modeling or statistical physics can add some theoretical work at a later stage of the project. A good level of English is required.

Paper to read before the interview: A. Tzur, R. Kafri, V. S. LeBleu, G. Lahav, M. W. Kirschner, Cell Growth and Size Homeostasis in Proliferating Animal Cells, Science 325 (2009) 167.

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